Photoresponse of Nanocrystalline n-TiO_2 thin Film and quantum wire Electrodes Towards Water-Splitting Reactions

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Introduction

The use of semiconductors for the photoelectrochemical splitting of water is well known [1-3]. In this study we report the photoresponse of nanocrystalline n-TiO_2 thin film and quantum wire electrodes towards water-splitting reaction. We also investigated the effect of methanol as depolarizer on photoelectrochemical splitting of water.

Experimental

The colloidal sol of n-TiO_2 was prepared using the method given in litersature (4). We fabricated the thin films of n-TiO_2 by spin coating using drops of n-TiO_2 colloidal sol on tin oxide coated glass substrate [5]. The thin film layer was then heated in an oven at optimum temperature of 750^o C for optimum time of 30 min. The quantum wire electrodes of n-TiO_2 was fabricated by placing an alumna membrane filter (0.2 µm pore size, 25 mm diameter; Fisher Scientific) on the SnO_2 coated glass substrate and then adding the sol drop by drop over the membrane filter, then dried in the air for 30 min and finally heated in an oven at 750^o C for another 30 min.

The Photocurrent–potential dependences of the thin film and quantum wire electrodes were studied in a glass cell with Pyrex glass window. The n-TiO_2 thin films or the quantum wires, a Pt electrode and a saturated calomel electrode (SCE) were used as working, counter and reference electrodes respectively. The electrolyte used was 5 M KOH. During measurements a constant intensity of 40 mW cm^{-2} of light was maintained from a Xe-lamp source (Hanovia model L-53**16).**

Results and Discussion

The Photoconversion efficiency as a function of applied potential of 1-layer thin film and quantum wire electrodes of n-TiO_2 are shown in figure 1. A more than two fold increase in the photoconversion efficiency (0.61±0.12%) was observed at quantum wire compared to that at the thin film electrodes (0.26±0.03%). The highest photocurrent density of 0.47 mA cm^{-2} was observed at 0.51 V/NHE. The higher efficiency in case of quantum wires can be attributed to its increased surface area. Adition of methanol as a depolarizing agent to the electrolyte KOH showed significant increase in the efficiency (1.17%) of the water splitting (figure 2). This maximum efficiency was at a potential of 0.41 V/NHE.compared to that at 0.51 V/NHE in the absence of methanol.

References

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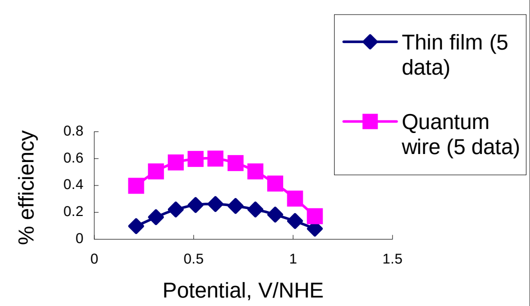

Figure 1: Photoconversion Efficiency as a function of Potential at n-TiO_2 Thin Film and Quantum Wire Electrodes

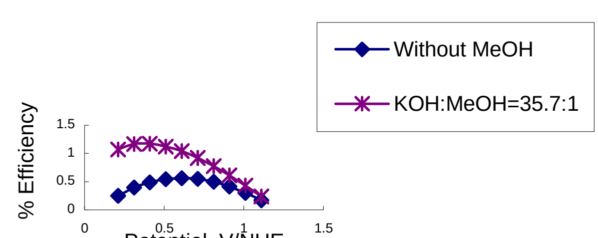

Figure 2: Effect of depolarizer (MeOH) on the % photoconversion efficiency for water-Splitting at at n-TiO_2 Quantum wire Electrodes.